

PROGRESS REPORT OF THE PARTIES CLIMATE CHANGE IMPACTS ANNEX CHAPTER

OVERVIEW

Climate change is an exacerbating stressor, which challenges the health of our Great Lakes ecosystems and the communities they support. Over 125 scientists and experts from the Great Lakes community within Canada and the United States are now monitoring the Great Lakes, including tracking the impacts of climate change, through specific indicator monitoring programs and reporting out through initiatives such as the State of the Great Lakes. These programs perform trend analysis and change detection assessments for air temperature, water levels, and ice duration. Current climate change concerns relate to greater fluctuations and possibly lower water levels across the Great Lakes region as well as rising lake temperatures and associated impacts on existing aquatic species and historic land covers (i.e., wetland loss) as well as possible introductions of non-native species (SOLEC, 2011).

Recognizing that climate change has an impact on the quality of Waters of the Great Lakes, Canada and the United States incorporated a new annex in the 2012 GLWQA to address this issue, through which both governments commit to coordinate efforts to identify, quantify, understand, and predict the climate change impacts on the water quality of the Great Lakes and to share information broadly with Great Lakes resource managers to proactively address those impacts.

ACTIONS TAKEN TO MEET KEY COMMITMENTS

Canada and the United States established the following Priorities for Science and Action, which helped focus the governments' efforts on key commitments from the Climate Change Impacts Annex that needed to be undertaken in the first three years (Table x).

Table x – Binational Priorities for Science and Action and Key Commitments

NATIONAL PRIORITIES FOR SCIENCE		KEY COMMITMENTS
<ul style="list-style-type: none"> • Compile existing knowledge on Great Lakes climate change. • After compiling Great Lakes climate change knowledge, assess and identify critical information needs and develop strategies to address those gaps. 		<ul style="list-style-type: none"> • Develop and Improve Regional Scale Climate Models to Predict Climate Change in the Great Lakes Basin at appropriate temporal and spatial scales. • Link the projected climate change outputs from the regional models to chemical, physical, biological models that are specific to the Great Lakes to better understand and predict the climate change impacts on the quality of the Waters of the Great Lakes.
<ul style="list-style-type: none"> • Address the needs of other GLWQA annexes for improved climate change science (e.g., understanding positive and negative impacts predicted under climate scenarios, monitoring of climate variables, improving tools for the analysis of climate change). • Communicate and share climate change information with key user groups throughout the Great Lakes basin. • Refine existing "Great Lakes Climate 		<ul style="list-style-type: none"> • Enhance monitoring of relevant climate and Great Lakes variables

BI N A TI O N A L P RI O RI TI E S F O R A C TI O N	<ul style="list-style-type: none"> • Address the needs of other GLWQA annexes for improved climate change science (e.g., understanding positive and negative impacts predicted under climate scenarios, monitoring of climate variables, improving tools for the analysis of climate change). • Communicate and share climate change information with key user groups throughout the Great Lakes basin. • Refine existing “Great Lakes Climate Summaries and Outlooks” factsheets with enhanced binational collaboration to produce and deliver climate information on a regular basis.
	<p>to validate model predictions and to understand current climate change impacts.</p> <ul style="list-style-type: none"> • Develop and improve analytical tools to understand and predict the impacts and risks to, the vulnerabilities of, the quality of the Waters of the Great Lakes from anticipated climate change impacts. • Coordinate binational climate change science activities (including monitoring modeling and analysis) to quantify, understand, and share information that Great Lakes resource managers need to address climate change impacts on the quality of Waters of the Great Lakes and to achieve the objectives of this Agreement.

Binational Actions Taken

Information Sharing (Commitment A9/C5)

Significant progress has been made towards compiling knowledge on climate change impacts, documenting critical information gaps, and sharing information across the Great Lakes region. Actions taken include, but aren’t limited to, the following examples:

In June 2013, Canada and the U.S. initiated the development of the first bi-national quarterly newsletter focusing on climate outlooks for the Great Lakes region. The “Great Lakes Quarterly Climate Summary” provides a quick and easy to understand binational overview of the latest season’s weather and water level conditions, weather and water level-related impacts and an outlook for the upcoming quarter. These Quarterlies are produced by U.S. and Canadian experts for use by managers and practitioners at federal, state, provincial, regional, and local scales as well as stakeholders and the general public in understanding the climate and water conditions, impacts, and outlooks across the basin. Electronic copies of these outlooks are archived and posted at <http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=36BCE9A0-1> and at <http://www.drought.gov/drought/content/resources/reports>.

In May 2014, information on climate change in the Great Lakes, based on the best available peer-reviewed science, was conveyed to members of all the Annex Subcommittees through a webinar. The purpose of this webinar was to enhance broad understanding of climate information needs among the

members of the Annex Subcommittees, who are responsible for considering climate change impacts, where applicable, in implementing actions related to the other issue annexes under the 2012 GLWQA. These webinar discussions were also an opportunity to initiate dialogue among the members of all of the Annex Subcommittees to determine the type of climate change information they would require and assist to focusing the work under the Climate Change Impacts Annex to provide more tailored climate change information. In August 2014 a similar presentation was delivered to the Habitat and Species Annex Subcommittee upon their request.

In 2015, Canada supported the development of a bi-national report documenting current climate change science and knowledge gaps across the Great Lakes basin. The 2015 State of Climate Change Science in the Great Lakes Basin report will inform the Annex 9 Subcommittee and support some of the commitments under Annex 9. The report was released in [November 2015] with a companion database that includes summaries of over 250 recent climate change studies. A binational Executive Summary of this report will be developed for posting on binational.net. In addition, a series of individual Annex-focussed webinars will be developed and hosted in the next cycle. It is anticipated that these webinars will lead to more fulsome discussions with the other Annexes on their understanding of climate change impacts and what their climate change information needs are. These discussions, along with a thorough review of the knowledge gaps identified in this report will also help the Annex 9 Subcommittee identify science and action priorities for the next cycle. [... talk about discussions w/ co-leads/subcommittees/GLEC to do x, y, z; will report assist in setting up next round of priorities?; talk about sharing widely with other groups for info sharing; talk about database of records hosted on x].

In addition to binational actions taken jointly by Canada and the United States, numerous domestic actions in support of the key commitments of the Climate Change Impacts Annex were also undertaken. Table x and Table x briefly outline some examples of these domestic actions. [possibly revise to include a similar line to the US intro line below]

Table x – Domestic Canadian Actions Taken

[Title]	[Succinct description of how domestic activity supported above priorities/commitments]
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Domestically, the United States has taken a number of new actions to meet the key commitments from the Climate Change Impacts Annex relating to climate and ecosystem modeling improvements, establishment of new monitoring programs, development of new analytical tools, and knowledge transfer to natural resource practitioners. These actions include, but are not limited to, the following in Table x.

Table x – Domestic U.S. Actions Taken

[Title]	[Succinct description of how domestic activity supported above priorities/commitments]
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Climate and Ecosystem Models (Commitment A9/C1 and C2)

The National Oceanic and Atmospheric Administration (NOAA) Great Lakes Environmental Research Lab (GLERL) brought together several different modeling and observational approaches to study climate change in the Great Lakes basin. The modeling activity consisted of further development and application, specifically for our lake-dominated region, of three coupled atmosphere-lake-land regional climate models: the Coupled Hydrosphere-Atmosphere Research Model (CHARM, based on the Regional Atmospheric Modeling System, RAMS) at NOAA/Great Lakes Environmental Research Laboratory, the Regional Climate Model version 4 (RegCM4) at the University of Wisconsin, and the Weather Research and Forecasting Model (WRF) at the University of Maryland; along with development and testing of a version of the Finite Volume Coastal Ocean Model (FVCOM) with enhancements for simulation of ice (FVCOM-Ice) and lower trophic level ecology in the form of a nutrient-phytoplankton-zooplankton-detritus (NPZD) model component.

Climate Monitoring (Commitment A9/C3)

In 2013, the Lake Superior National Estuarine Research Reserve established a new Sentinel Site located in Pokegama Bay, Lake Superior. With funding support from NOAA, this Sentinel Site included weather/meteorological station, water quality sonde, surface elevation tables, permanent vegetation transects, geodetic vertical referencing benchmarks, and an acoustic doppler current profiler installations. This site is now recording monthly water quality sampling for nutrients and chlorophyll. The primary goal is to understand sediment movement and the consequence of sediment movement to marsh sustainably under the expectation of the increased frequency and intensity of storm events.

NOAA-GLERL has been exploring the relationships between ice cover, lake thermal structure, and regional climate for over 30 years through development, maintenance, and analysis of historical model simulations and observations of [ice cover](#), surface water temperature, and other variables. Weekly ice cover imaging products produced by the Canadian Ice Service started in 1973. Beginning in 1989, the U.S. National Ice Center produced Great Lakes ice cover charts that combined both Canadian and U.S. agency satellite imagery. These products are downloaded at GLERL by our Coastwatch program, a nationwide NOAA program within which the GLERL functions as the Great Lakes regional node.

Currently, there is year-round monitoring infrastructure dedicated to understanding off-shore processes that impact Great Lakes ecosystem health. Beginning in FY15, NOAA GLERL (with funding support from the NOAA Coastal Storms Program) is seeking to fill these data gaps through a two-phased approach. First, the team will deploy and manage data from vessel- and buoy-based sensors to improve understanding of over-water meteorology, evaporation, and water temperature in the Great Lakes. Second, the project will also focus on data analysis, system validation, and model assimilation to improve access to and understanding of the acquired data.

Analytical Tools (Commitment A9/C4)

NOAA's Office for Coastal Management developed and released the [Lake Level Viewer](#) for the U.S. portion of the Great Lakes basin in 2014. This tool helps users visualize lake level changes that range from six feet above to six feet below historical long-term average water levels in the Great Lakes, along with potential shoreline and coastal impacts. Communities can use this information to determine what preparations make the most sense in planning for water level change scenarios. Preparations might

include zoning restrictions, infrastructure improvements, and habitat conservation. As a result of this work and product delivery, Digital Elevation Models are now available for each Lake Basin and the associated topographic and bathymetric data are being served on NOAA's Digital Coast.

NOAA GLERL developed and released a basin wide [Water Level Dashboard](#) in 2014. The Dashboard is a dynamic graphical interface for visualizing projected, measured, and reconstructed surface water elevations on the earth's largest lakes. This interface also reflects relationships between hydrology, climate, and water level fluctuations in the Great Lakes.

Sharing Information (Commitment A9/C5)

NOAA's National Center for Environmental Information produces an annual "[State of the Climate](#)" report. This report provides a collection of monthly summaries recapping climate-related occurrences on both a global and national scale.

Environmental Progress

[If available and relevant, include latest relevant SOLEC indicator info to provide a highlight of the environmental progress achieved *as a response to* undertaking the above actions. Target length: 400 characters.]

[Repeat this approach for each key commitment as necessary.]

References

SOLEC, 2011 ...